

SEARCHING FOR A COMA DURING THE NEW HORIZONS FLYBY OF 2014 MU69 (ULTIMA

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Introduction and Background: Due to its small size, it is likely that any volatiles that might have once been present on 2014 MU₆₉ (MU69, unofficially known as “Ultima Thule”) are now gone, having long ago escaped to space [1]. However, as a cold classical, the New Horizons KBO target was expected to have formed in its current vicinity, have a red color, have a relatively high albedo, and be a binary [2]. Initial results from the 2019 January 1 New Horizons flyby largely confirm these expectations [3]. Models have suggested that methanol (CH₃OH), acetylene (C₂H₂), ethane (C₂H₆), hydrogen cyanide (HCN), and ammonia (NH₃), could be retained by cold classical objects over solar system evolution time scales, and that processing (e.g., irradiation) of these species could lead to their red coloration [4]. Recent observations further suggest that the surface reddening of KBOs by irradiation of volatiles is an ongoing process [5]. While such volatiles are quite stable on the surface at their expected temperature, ongoing radiation processing implies a slow loss of hydrogen atoms to space as the surface ices are converted into tholins. In addition, occasional impacts provide a possible source for a transient atmosphere.

These considerations led the New Horizons team to perform a series of observations to search for a coma around MU69 [6,7]. Such a transient atmosphere was searched for using the Alice [8] ultraviolet spectrograph—in absorption, using stellar and solar appulses (as well as the sky background of interplanetary Lyman- α), and in emission, using resonantly scattered solar emissions. Dust associated with MU69 was also searched for with high phase angle LORRI [9] and MVIC [10] imaging, although low-phase approach observations have already placed a strict upper limit on the nearby dust opacity [11].

SWAP [12] and PEPSSI [13] observations were also made to establish the interaction of the solar wind and interplanetary medium with MU69, e.g., looking for pickup ions resulting from sputtering of surface materials, and the SDC [14] was used to monitor dust impacts during the flyby. These in situ particle results are reported elsewhere [15].

Observations and Initial Results: As stated above, the Alice observations included searches for a

coma at MU69 through 1) molecular absorption of background ultraviolet sunlight and starlight, and 2) atomic emissions of resonantly scattered sunlight. Since resonance line cross sections are typically $\sim 1000\times$ larger than absorption cross sections, we expect that the most constraining limits on the coma density will come from the search for resonance emissions near MU69. We currently have about 104 minutes of pointed “airglow” observations on the ground which were taken at low phase angle during approach (89 minutes at a range between 1.32 and 1.24 million kilometers, and 15 minutes at a range between 92.1 and 78.7 thousand kilometers). At the likely brightest coma emission of the hydrogen Lyman- α line at 121.6 nm, these data indicate a preliminary upper limit of $<2\times 10^{25}$ H atoms released by MU69 each second. For comparison, the loss rate from photo-sputtering of water ice on MU69 is expected to be $\sim 1\times 10^{19}$ H atoms each second.

An initial inspection of all atmospheric datasets received to date reveal no evidence of airglow emission or absorption. Additional data are being downlinked prior to the LPSC meeting, and further limits on an MU69 coma will be provided.

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